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Procedia - Social and Behavioral Sciences 90 (2013) 853 – 861

Procedia
Social and Behavioral Sciences

6th International Conference on University Learning and Teaching (InCULT 2012)

Lecturers' Perceptions, Students' Problems and Solutions for Handling High-Failure Rate Mathematics Courses

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Abstract

This study aims to determine the lecturers' perceptions and problems encountered by students in learning high-failure rate Mathematics courses. Suggestions to remedy the current Mathematics high-failure rate situation are also explored. Questionnaire was given to lecturers who had experiences in teaching high-failure rate Mathematics courses. Descriptive statistics and qualitative analysis are used to analyze the data. The finding indicates that the level of difficulties for all the Mathematics courses under study, which comprise mainly Calculus are rated at least difficult subjects by the lecturers. There are some obvious variations in the students' frequency in the usage of instructional systems. Students rely heavily on lecture notes as their basis for learning. Students' frequency in the usage of concrete materials or equipment to explore Mathematics ideas is still below average as perceived by lecturers. Lecturers' indication on students' frequency of working in small groups to solve Mathematics problems is slightly above average. Students frequently practiced Mathematics procedures only in classroom as compared to making conjectures or exploring more than one possible method to solve Mathematics problem. Based on the feedback given by Mathematics lecturers, students are basically weak in basic foundation of Mathematics and do not really understand the concept of basic Calculus. Other problem that has been identified includes the difficulty in identifying the suitable method to solve a particular problem.As a solution, students should play their part by studying hard and always consult lecturers on their learning difficulty. For the lecturers, teaching method must be properly sequenced and well-organized.

Selection and/or peer-review under responsibility of the Faculty of Education, University Technology MARA, Malaysia.

Keywords: lecturers' perception; students' problems; solutions; high-failure rate; Mathematics courses

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doi:10.1016/j.sbspro.2013.07.161

1. Introduction

Many researchers have acknowledged the importance of basic Mathematics knowledge in learning and understanding of new Mathematics knowledge (Gynnild, et al., 2005; Hailikari, et al., 2007). According to Hailikari, et al. (2007), basic knowledge has a great influence on student's achievement, and it is worth to measure the effect of basic knowledge on student's achievement. However, international research studies have reported underachievement in Mathematics (Blankley, 1994; Nongxa, 1996). According to (Suresh, 2002), Calculus is one of the 'high-failure rate' courses for engineering students besides Physics and Statistics.

According to Joiner, et al. (2002), the implementation of Calculus reformed education, similarly has not produced consistent results. Therefore there is a towering likelihood that students' Mathematics grades at *SijilPelajaran Malaysia* (equivalent to O-level examination) level have a causal outcome on their performance in the 'high-failure rate' course. Besides, evidence from past research suggests that lecturers' attitudes and perceptions towards Mathematics affect their teaching and students' learning of Mathematics (Hart, 2002). Perry (2007) reported lecturers-related factor as important issue in Mathematics education.

In this study, high-failure rate Mathematics course is defined as Mathematics course offered to full-time diploma students in the public university under study that had an average passing rate below 70% for the past 7 semesters. The objectives of this study are to determine the lecturers' perceptions on high-failure rate Mathematics courses, to investigate the problems encountered by students in learning high-failure rate Mathematics courses and to propose solutions to remedy underachievement in high-failure rate Mathematics courses.

1. Literature Review

The literature review is further elaborated in few sections, naming lecturers' perceptions towards Mathematics teaching and learning, and strategies taken to improve students' Mathematics learning.

1.1. Lecturers' Perceptions Towards Mathematics Teaching And Learning

Evidence from past research suggests that lecturers' attitudes and perceptions towards Mathematics affect their teaching and students' learning of Mathematics (Hart, 2002). For the new generation of today which puts much emphasis on e-learning, lecturers' perceptions on students' Mathematics learning need to be researched. In the light of this matter, there is indeed a need for some evaluations on teaching and learning of this subject matter at this level.

Students' learning approach varies in accordance to the learning environment exhibited in the classroom (Ramsden, 1984). Concrete materials are deemed as necessary in assisting students to understand a mathematical idea (Perry, 2007). With solid learning materials, Mcnair (2000) proposed classroom discussions as an attempt to help students to grasp difficult concepts. Nagasaki and Senuma (2002) revealed that Japanese teachers perceived students' ability to think creatively as an important element to succeed in Mathematics. However, they may have to change their perspectives on the thought that Mathematics is not really useful in terms of application in the real world, as it may influence a student's attitude towards Mathematics.

According to Oaks (1990), students who perceived Mathematics as meaningless symbols tend to memorize in order to succeed. Perry (2007) reported that Australian Mathematics teachers regarded the importance of memorization in order to recall relevant information, but disagreed when memorization is associated with drilling and rote learning. Their opinion was that practice will gradually help to build up the memory. Porter and Masingila (2000) suggested that students learned to do more writings as a way to build understanding, which eventually helped them to convey and share their knowledge with others. With this, it is hoped that Mathematics students could learn how to communicate logically on their solutions in a standard format. Students tend to pay much attention in procedural knowledge instead of understanding the concepts (Porter and Masingila, 2000). Without the understanding of a mathematical concept, student will not be able to apply the concept in a novel

situation (Perry, 2007). This problem can be seen in the traditional Mathematics teaching and learning where problem solving revolved around fixed and ritualistic algebraic manipulations procedures.

Beside students-related factor, Perry (2007) also reported lecturers-related factor as important issue in Mathematics education. In addition to lecturer's knowledge of course and syllabus, lecturer's flexibility, and stability of structure, lecturer who is full of enthusiasm and passion in Mathematics is believed to have the ability to deliver content of syllabus and knowledge effectively to students. They are co-learners with the students and have the abilities to show to their students the relevance of Mathematics in today's society (Perry, 2007).

2.2 Strategies Taken to Improve Students' Mathematics Learning

Dungan and Thurlow (1989) reported that there is no evidence of association between students' attitudes to Mathematics and exposure to alternative teaching approaches or between students' attitudes to Mathematics and new technology. However, despite the comment by Dungan and Thurlow (1989), students' attitudes are partly influenced by lecturers' perceptions (Nagasaki and Senuma, 2002). Having known this, which in turn affects teaching and learning of Mathematics at various university levels, researchers and academicians everywhere around the world are implementing various strategies to address the problems.

In Singapore, a group of researcher from Nanyang Technological University (Ahuja, et al., 1998) has suggested improvements on curriculum and teaching strategies, use of technology, infusing thinking and creativity, and provision of training as solutions to improve Calculus and Mathematics education. Professional development in Mathematics is beneficial for lecturers to increase understanding of instructional material as well as deepen knowledge on Mathematics and pedagogy. There are various organizations which provide professional development and professional learning opportunities with the aim to improve student achievement as one of its goals such as National Council of Teachers of Mathematics (NCTM) andNational Council of Supervisors of Mathematics (NCSM).

Ponte (2007) reported of students' development in Mathematical understanding through investigation and exploration tasks in the classroom by using a specific teaching unit which he had constructed. However, Ponte pointed out investigations have a role to fulfill, contributing to achieve some curriculum objectives, but there is no claim that they will enable to achieve all the objectives of the discipline.

3.0 Methodology

This study is a survey research which aimed to investigate the lecturers' perceptions and problems encountered by students on high-failure rate Mathematics courses. This study aims to remedy the current Mathematics high-failure rate situation. Hence, various suggestions are given by experienced Mathematics lecturers to help lecturers and students in Mathematics teaching and learning. Triangulation of data is not looked into in this study as the data are mainly collected through questionnaire.

3.1 Population

To determine the lecturers' perceptions, students' problems and suggestions on high-failure rate Mathematics courses through questionnaire, the respondents of this study consisted of the lecturers who had taught the high-failure rate Mathematics courses. The lecturers had experiences in teaching high-failure rate Mathematics courses in one of the public university in Sarawak, Malaysia.

3.2 Instrument

For the purpose of studying lecturers' perceptions, students' problems and suggestions on high-failure rate Mathematics courses, questionnaire was given to the respective lecturers. The respective lecturers had experiences in teaching the high-failure rate Mathematics courses. The questionnaire for the lecturers was

intended to gather information on the lecturers' perceptions, students' problems and suggestions towards high-failure rate Mathematics courses.

The questionnaire for the lecturers was generally divided into three parts. Part A comprised the information on the respondent's demographic, such as the gender and the length of service as lecturer. Part B was asking on the lecturers' Mathematics teaching experience.

In Part B question 1, the lecturers were asked to rate the difficulty level of the Mathematics courses using a "1" (very easy) to "5" (very difficult) scales. In question 2, the lecturers were asked on the students' frequency in using the stated instructional systems in their lectures. Part C consisted of open-ended questions whereby the lecturers were asked to give their opinions regarding the problems and the factors contributed to the occurrence of the high-failure rate Mathematics courses. Besides, they were also asked to give suggestions to improve the students' performance in high-failure rate Mathematics courses.

The questionnaire for the lecturers was designed with reference to Ferrini-Mundy (1994). One Mathematics lecturer and one language lecturer from the public university under study were asked to check and verify the items in the questionnaire in order to meet the objectives of this study. Corrections, including the grammatical errors and the construct of the items in the questionnaire were made before the questionnaire wasdistributed to the respondents of this study.

3.3 Data Collection Procedure

For the purpose of studying the lecturers' perceptions, students' problems and suggestions on high-failure rate Mathematics courses, questionnaire was distributed to the lecturers who had taught high-failure rate Mathematics courses. Questionnaire for the lecturers was answered by those lecturers who had taught the high-failure rate Mathematics courses. Later, those lecturers returned the questionnaire to the researchers.

3.4 Data Analysis Procedure

Analysis of the lecturers' perception, the descriptive statistics was calculated to elicit the lecturers' perception on the high-failure rate Mathematics courses. The content analysis was also being carried out on the open-item feedback to categorize the suggestions given by the lecturers. Qualitative analysis was carried out at the later part of the lecturers' questionnaire in order to analyze the feedback.

4.0 Finding

The finding is further divided into three sections which aim to answer the objectives of this study. Three sections consist of lecturers' perceptions on students' difficulty and approach in Mathematics learning, problems encountered by students in learning high-failure rate Mathematics courses and solutions to improve students' performance in high-failure rate Mathematics courses.

4.1 Lecturers' Perceptions on Students' Difficulty and Approach in Mathematics Learning

A total of 11 Mathematics lecturers (4 males, 7 females) who have experiences in teaching high-failure rate Mathematics courses in Department of Mathematics in a public university in Malaysia responded to the questionnaire, which is about 61% of the total number of lecturers from the department. Findings included lecturers' indication on students' difficulty in learning high-failure rate Mathematics courses, students' frequency in the usage of instructional systems, problems encountered by students in learning high-failure rate Mathematics courses and suggested solutions which aimed to remedy underachievement in high-failure rate Mathematics courses.

4.1.1 Level of Course Difficulty as Experienced by Students

Figure 1 indicates how lecturers rate the level of difficulty that is experienced by students in learning the high-failure rate Mathematics courses and several other Mathematics courses, in which the main composition of Mathematics major consist of Calculus. The rating used is "1" = very easy … "5" = very difficult.

All the Mathematics courses, which comprise mainly of Calculus have ratings of at least 3.0. MAT142 (Mathematics 1B), which is taken by students from the Engineering, Computing and Quantitative Science program and MAT238 (Calculus II for Scientist), which are taken by students from the Computing and Quantitative Science program are rated as neutral. Three courses, namely MAT149 (Calculus I), MAT241 (Mathematics 3A) and MAT293 (Engineering Mathematics I) have been perceived as the most difficult course, as experienced by students of Computing and Engineering program. Differences in the rating of difficulty level for Pre-Calculus courses such as MAT133, MAT142 and MAT143 may be due to the category of program. Similar situation can be seen for Calculus I courses (MAT149, MAT183 and MAT192) as well as Calculus II courses (MAT199, MAT235 and MAT238), which differ in ratings as students from Engineering programs may have different mathematical capability as compared to students from the Science or Computing program.

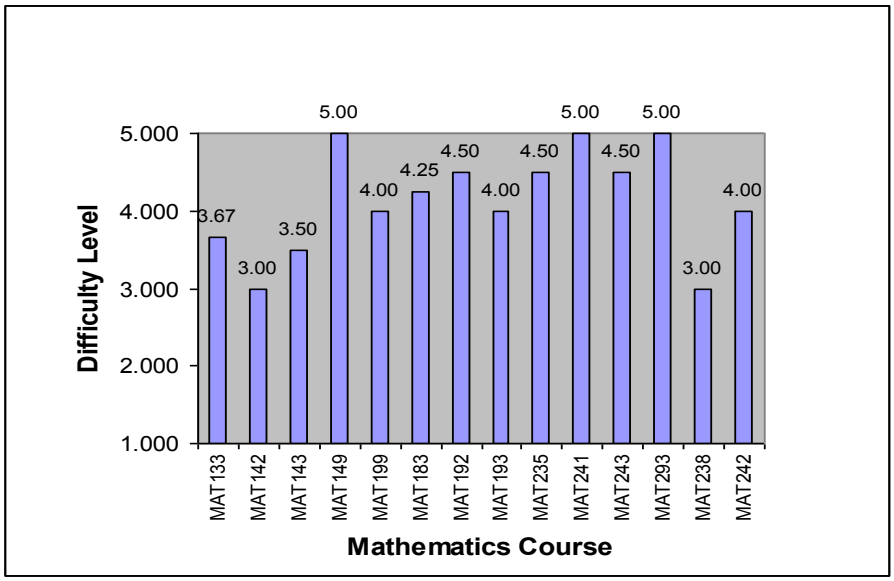

Figure 1. Lecturers' indications on course difficulty level as experienced by students.

4.1.2 Students' Frequency in the Usage of Instructional Systems

In question 2 of Part B, lecturers are asked to rate students' frequency in using the instructional systems. The instructional systems consist of three main types, namely curriculum resources (question a, b and c), small groups (question d and e) and problem solving procedures or methods (question f and g). The results obtained is shown in Figure 2 ("1" = not frequent … "5" = very frequent).

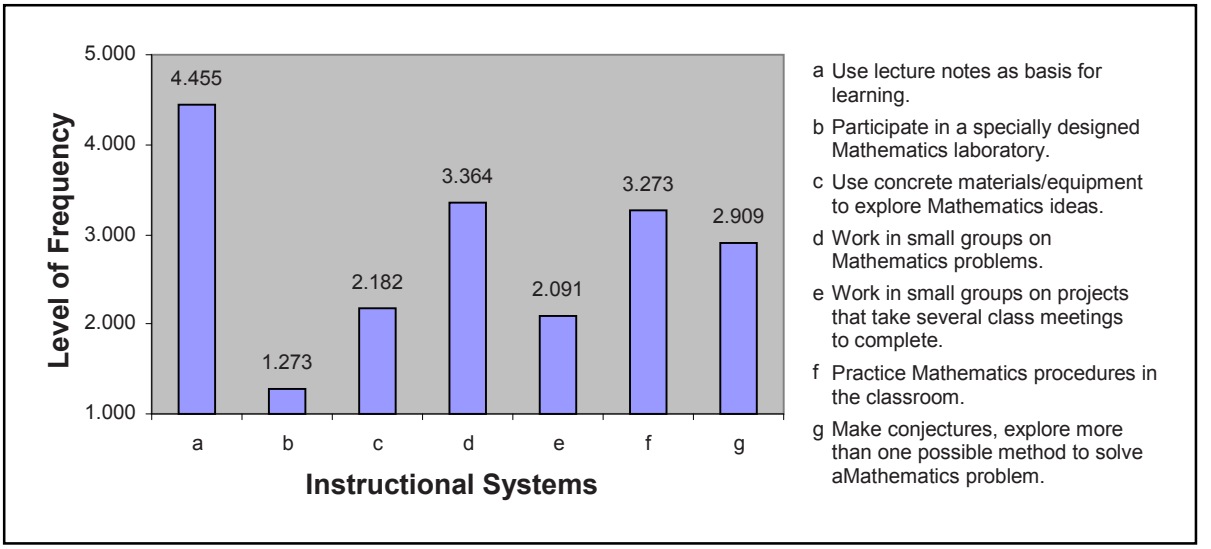

Figure 2.Lecturers' indications on students' frequency of instructional systems usage.

The results obtained as shown in Figure 2 indicate that there are some obvious variations in the students' frequency in the usage of instructional systems. There are four instructional systems which have frequency level below average, while only three instructional systems which have level of frequency more than 3.0. For each main type of instructional systems, there is one category which managed to score above the mean rating of 3.0.

Figure 2 shows that students rely heavily on lecture notes as their basis for learning. The very low frequency on students' participation in a specially designed Mathematics laboratory is possibly due to the manner on how certain syllabus is implemented, in which the sufficiency of laboratory facilities are also taken into consideration by the Faculty. As of today, only Pre-Calculus course such as MAT133 course has started to use MAPLE software to enhance Calculus learning as part of its curriculum design. Students' frequency in the usage of concrete materials or equipment to explore Mathematics ideas is still below average as perceived by lecturers. Since lecturers indicate that the general usage of curriculum resources among students is still below average, practical steps could be taken to help students to increase their frequency in the usage of curriculum resources, especially in using concrete materials for Mathematics exploration.

Lecturers' indication on students' frequency of working in small groups to solve Mathematics problems is slightly above average. However, it is not a norm for students to work in small groups on projects that take several class meetings to complete. The resulted below average frequency is likely owing to the fact that the way syllabus is structured to target on solving short procedural Mathematics problems.

Students are more frequent in practising Mathematics procedures in classroom as compared to making conjectures or exploring more than one possible method to solve a Mathematics problem. The later required students to perform critical thinking, and usually excites those who are already in the habit of exploring new ideas or those who are mathematically challenged to believe that they can come out with alternative methods or problem solving procedures. Regardless of the varieties in classroom teaching approaches, lecturers need to help students to increase their frequency in using the instructional systems, whenever it is within their reach.

4.2 Problems Encountered by Students in Learning High-Failure Rate Mathematics Courses

Based on the feedback given by the Mathematics lecturers, students are basically weak in the basic foundation of Mathematics and do not really understand the concept of basic Calculus. For example, when students are given

the formula for evaluating limit, they may be able to find the answer, but they do not understand how limit can be compared mathematically and realistically in real world. Mundy (1984) noticed `a disturbing tendency of calculus students to operate at a rote level of procedures and symbol manipulation, not supported by an understanding of the concepts involved'.

Other problem that has been identified includes the difficulty in identifying the suitable method to solve a particular problem, such as differentiation and integration which has few methods. In fact, students always encounter problems in solving derivatives and integrals because they are confused with the various integration and differentiation techniques due to lack of initiative to do exercises. Unable to think critically in complicated situation or procedures has made them ignorant to the conceptual aspects of the subject and relied more on memorizing the rules and procedures.

4.3 Solutions to Improve Students' Performance in High-Failure Rate Mathematics Courses

Because students underachieved for so many different reasons, there is no single intervention strategy that can possibly reverse all these behaviors in all underachieving students. Nevertheless, both lecturers and students need to play an important role in order to improve students' performance in high-failure rate Mathematics courses. Based on the received feedback, the following are some useful suggestions given by the Mathematics lecturers that can be practised by students, lecturers and the faculty of the university.

4.3.1 Students

Students must develop regular study habits by attending lectures and tutorial as well as attempting to do assignments and exercises in order to master the knowledge. In high-failure rate Mathematics courses, a thorough knowledge of the previous material is essential to reach an understanding of new material. Hence, falling behind tends to be cumulative and is one of the most frequent causes of failure, as understanding grows with time and experience. Therefore, students should play their part by studying hard and always make an effort to consult the lecturers concerned when they are having difficulty in learning high-failure rate Mathematics courses. They should not delay in asking for assistance or prolong their problems until a day before the exam because it is quite impossible for them to cram Mathematics knowledge and concept at the very last minute. Learning high-failure rate Mathematics courses involve development of skills and understanding that must be consolidated over a period of time.

Based on the experiences in teaching high-failure rate Mathematics courses, most of the lecturers have encouraged the students to take the course during a less packed semester with no other killer subjects. This is to help the students to have sufficient time and energy to concentrate more on the subject taken. Students who are re-taking a particular subject should not try to load themselves with too many subjects in order to avoid any future failures.

4.3.2 Lecturers

In order to improve students' performance in high-failure rate Mathematics courses, the lecturers' teaching method must be properly sequenced and well-organized. The teaching approach must be effective and tally with the level of understanding of the students. The use of certain courseware and the implementation of new teaching and learning methods such as concept mapping and mind mapping can help students to visualize the abstract concept and enhance their understanding in the process of learning. The lecturers must be competent and show the ability to guide students in identifying the correct skills in answering various Calculus problems. Instead of simply giving them the solutions to mathematical problems, lecturers could train their students to actively work for alternative solutions which help them to think creatively.

4.3.3 Faculty Level

A review on high-failure rate Mathematics syllabus for each program should be made to make sure that there is a flow on delivering the Mathematics concepts and the contents are relevant to the needs of an ever changing work market. Perhaps, the Department of Mathematics should seek out better teaching methods and strategies to make the learning of high-failure rate Mathematics courses more interesting and effective. In addition, the department could also consider setting up a Calculus clinic or Mathematics motivational seminars in the campus to help those students who are facing problems in Mathematics.

5.0 Conclusion

This paper has given an account of lecturers' perceptions on students' difficulties in fourteen diploma level mathematics courses, and the reasons for students' underachievement from the approach of instructional systems. The present study was designed to determine the lecturers' perceptions on high-failure rate Mathematics courses, to investigate the problems encountered by students in learning high-failure rate Mathematics courses and to propose solutions to remedy underachievement in high-failure rate Mathematics courses. These findings suggest that in general, 85.7% of mathematics courses recorded difficulty level as experienced by students above the average level as indicated by lecturers. Meanwhile, students of Calculus I (MAT149) were rated 'very difficult' as compared to students of Calculus I (MAT183) whose rating was 'difficult'. This could be due to the reason that Computer Science students do not study Pre-Calculus (MAT133) which is a pre-requisite subject for Engineering students. Nevertheless, Engineering students continued to struggle in higher level of Mathematics courses which contained significant portion of Calculus. It was also shown that in overall, students depended very much on lectures notes as basis for learning as indicated by lecturers. Though students' participation in small groups and classroom were above average, but other instructional systems such as students' participation in specially designed mathematics laboratory and usage of concrete materials for mathematical exploration were below average.

The major problem that caused students' underachievement was students' poor foundation in basic calculus. The problem of acquiring good result in calculus is well documented from previous studies (Gynnild, et al., 2005; Wieschenberg, 1994; Madison and Hart, 1990). As they progressed to higher level courses, their poor conceptual understanding of calculus became an apparent hindrance in learning new concepts. In the interim, lecturers as respondents to this study had also outlined few possible solutions, in which students, faculty level and lecturers themselves must co-worked together to bring down the failure rate of mathematics courses. Students who are struggling to understand basic mathematics concepts from the very beginning of the semester should quickly enrol themselves in remedial classes where lecturers can follow-up on their performance. There is also a need for lecturers to review and revamp the deliverance of calculus concepts by using visual approach such as concept mapping or other mapping techniques and also integrating technology into the teaching and learning. At the faculty level, it is essential to reassess and make important changes to the syllabus of high failure rate mathematics courses to ensure that the contents are meeting the requirements of the concerned diploma programs.

The evidence from this study suggests that the lecturers' perceptions on students' difficulties and approaches in high failure rate Mathematics courses must be taken seriously at the faculty level. While any revamp in syllabus at the faculty level may take longer time to implement, it is high time for lecturers to be creative in the construction and implementation of instructional systems. The study has gone some way towards developing our understanding of students' norm in learning Mathematics and Calculus, the lacks and excesses and how to create balance beyond the regular means. The present study has only examined the students' difficulties in high failure mathematics courses as perceived by lecturers from the aspect of students' way of learning. A further study could assess students' difficulties in high failure rate Mathematics courses from other students' factors such as attitudes. This information can be used as guidelines in developing contents of diploma programs that have substantial amount of Calculus courses.

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